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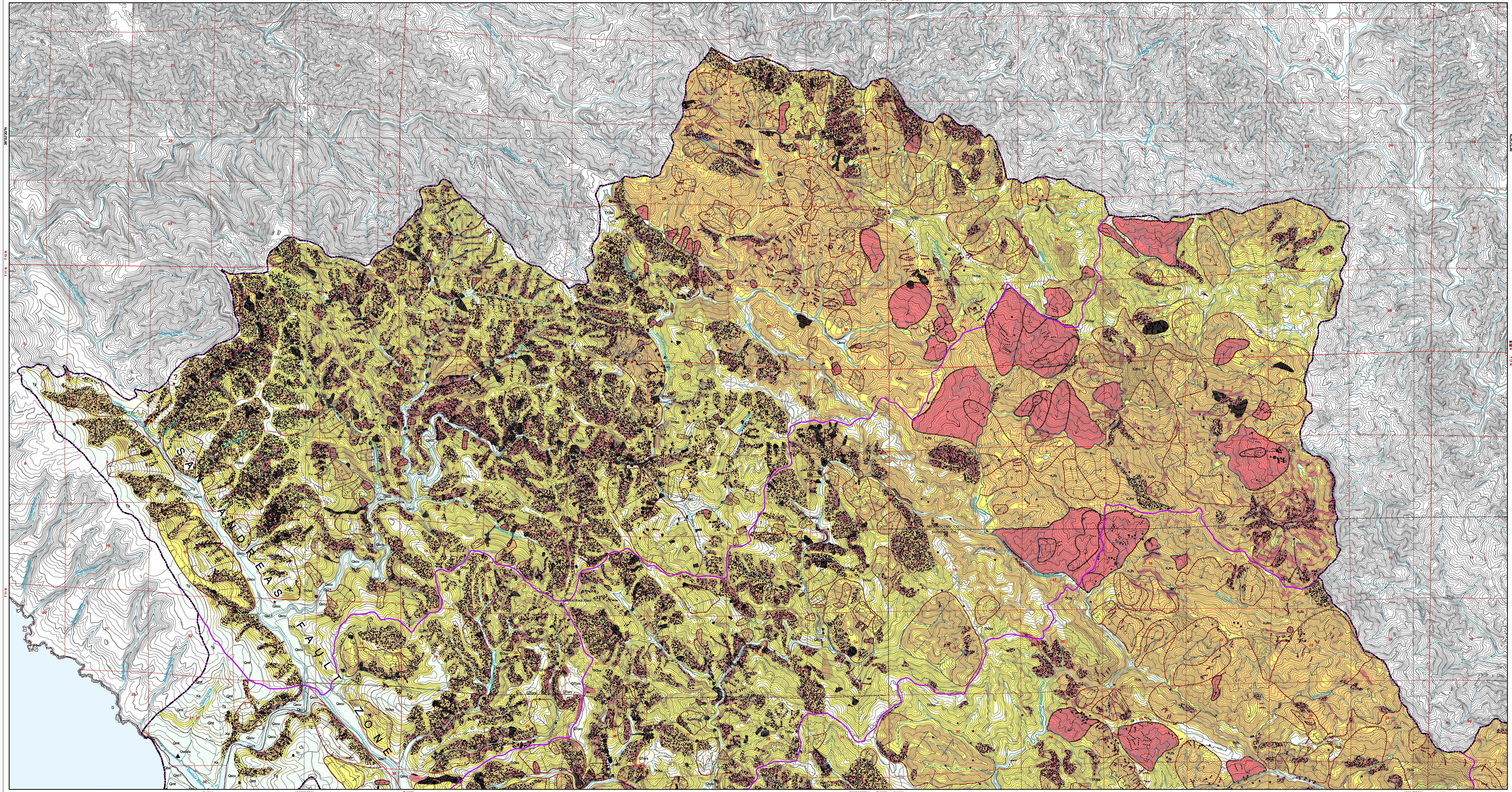

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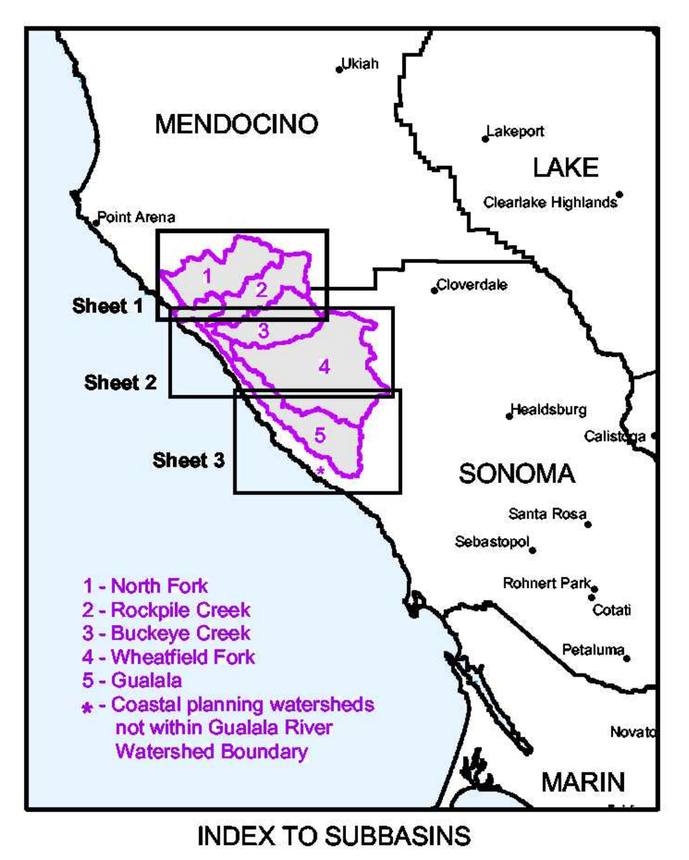

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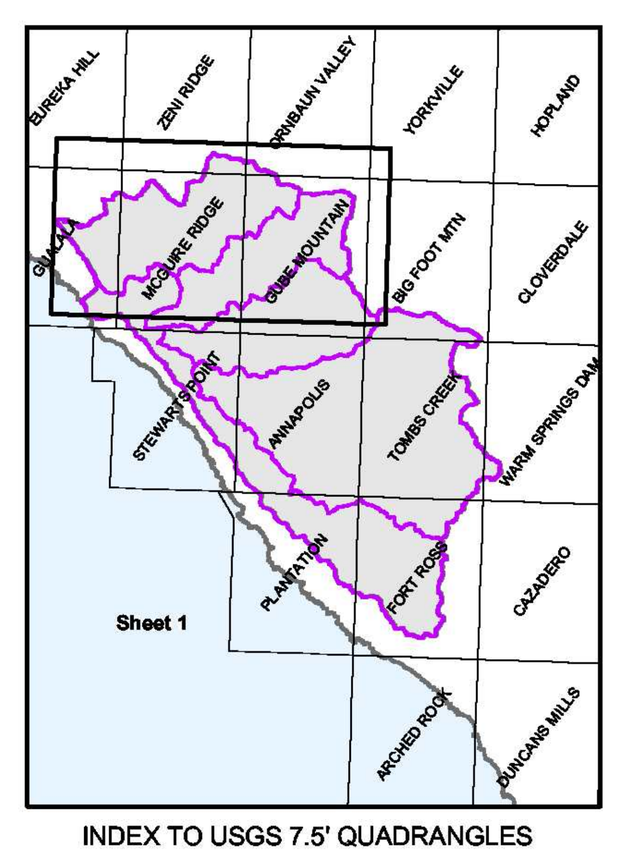

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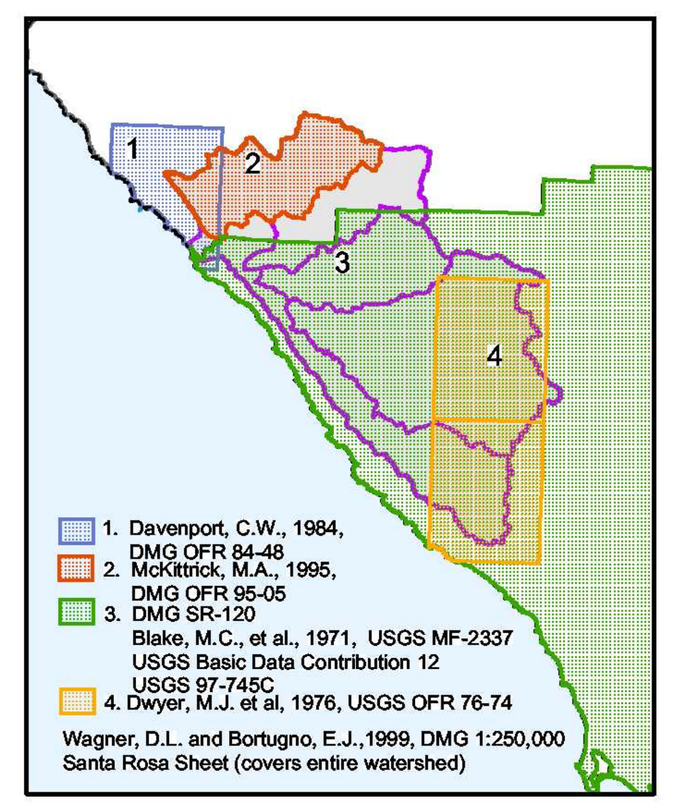
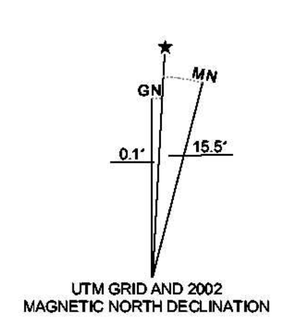


INDEX TO GEOLOGIC AND GEOMORPHIC MAPPING REFERENCES



UTM GRID AND 2002 MAGNETIC NORTH DECLINATION

MAP LOCATION

SCALE 1:24 000

MILES · FEET · KILOMETERS · METERS

RELATIVE LANDSLIDE POTENTIAL CATEGORIES

1 VERY LOW LANDSLIDE POTENTIAL Landslides and other features related to slope instability are very rare to non-existent within this area. This area includes relatively flat marine terraces, lower stream valleys, and flat topped ridges in the Gualala River watershed.

2 LOW LANDSLIDE POTENTIAL Gentle to moderately steep slopes underlain by relatively competent material that is considered unlikely to mobilize as landslides under natural conditions given the current understanding of regional seismicity. Landsliding in these areas is not common. This area generally includes the flat-topped ridges of the Ohlson Ranch Formation and marine rocks west of the San Andreas Fault.

3 MODERATE LANDSLIDE POTENTIAL Moderate to moderately steep, relatively uniform slopes that are generally underlain by competent bedrock, may also include older dormant landslides. Some slopes within this area may be at or near their stability limits due to weaker materials, steeper slopes, or a combination of these factors. This area dominantly occurs in dormant landslides west of the San Andreas Fault and in the rocks of the Coastal Terrane west of the Tombs Creek Fault zone. Landslides typically occur as small (less than 1 acre) debris flows, debris slides, and rockslides.

4 HIGH LANDSLIDE POTENTIAL Moderately steep to steep slopes that include many dormant landslides in upslope areas and slopes upon which there is substantial evidence of downslope creep of surface materials. This area consists of large dormant earthflows dominantly occurring in the rocks east of the Tombs Creek Fault zone, areas of disrupted ground on moderately steep (30-64%) slopes, and much of the incised and moderately steep area of the Coastal Terrane.

5 VERY HIGH LANDSLIDE POTENTIAL Areas include historically active landslides (<150 years old) and inner gorges, as well as debris slide/flow source areas on steep to very steep slopes (>65%). Landslides typically occur as large earthflows in the Central Terrane east of the Tombs Creek Fault zone and as small (less than 1 acre) rock slides, debris slides, and debris flows in the Coastal Terrane.

INFORMATION CONCERNING THE RELATIVE LANDSLIDE POTENTIAL MAP

PURPOSE

The North Coast Watershed Assessment Program (NCWAP) and the Timber Harvest Plan Enforcement and Watershed Restoration Program (THPEWRP) of the California Geological Survey (CGS) prepares two types of maps, 1) Geologic and Geomorphic Features Related to Landsliding Maps and 2) Relative Landslide Potential With Geologic and Geomorphic Features Maps (Relative Landslide Potential Maps) to aid in land management of California's North Coast. The two CGS programs follow standardized procedures and methods (described below) for map development in a Geographic Information System (GIS). Thus, the Relative Landslide Potential Maps produced by NCWAP and THPEWRP are consistent on a statewide basis in the assignment of relative landslide potential categories.

This Relative Landslide Potential Map was developed to depict areas that are relatively more or less susceptible to landsliding based upon the geologic observations and interpretations presented on the Geologic and Geomorphic Features Related to Landsliding, Gualala River Watershed map (Plate 1). This map shows on a regional scale (1:24,000) five categories of relative landslide potential. The map can be used as a screening tool in project level or regional planning, but does not serve as a substitute for more specific evaluation and ground-based observations. Site-specific evaluations often require detailed engineering geologic studies and quantitative soil engineering investigations of the underlying soil and bedrock for proper planning of specific projects.

METHOD

This map only identifies potential landslide source areas. It does not depict the potential for downslope areas to be inundated by debris flows, rockfalls or other types of landslides. In general, the boundaries of the landslide potential areas are determined by combining observations shown on the Geologic and Geomorphic Features Related to Landsliding, Gualala River Watershed map (Plate 1), with judgments and interpretations of geologic information drawn from the experience of the authors with the field-area at the time the map was developed.

The Relative Landslide Potential Map is derived from a Geographic Information System (GIS) based compilation of data used to prepare the Geologic and Geomorphic Features Related to Landsliding, Gualala River Watershed map (Plate 1). The GIS ensures a consistent interpretation of geologic, geomorphic, and topographic conditions throughout the watershed. In producing this Relative Landslide Potential Map, it is assumed that historically active slide material has the lowest relative strength, and thus, the highest relative potential for landsliding of all geological materials underlying the slopes. Recent alluvial deposits in the valley bottom are assumed to possess the least potential for landsliding due to their flat slope. This derivative map illustrates five broad categories of relative potential for the occurrence of landsliding with these extremes as end points. Those categories were derived from values assigned to variables shown in the metadata file. The values were assigned based on interpretation of the significance of each variable within the Gualala River watershed. Variables considered were 1) occurrence and distribution of landslides, including the activity level and mechanics (specific process) of downslope sliding for each landslide, 2) presence of geomorphic features related to landsliding and slope instability, 3) steepness of slopes whether or not landslides are apparent, 4) the geology of the area, including bedrock types and lithologic properties relative to slope stability and distribution of various earth materials, as well as the structural framework, such as faulted and folded strata found in the region, and 5) relative behavior of slopes based on interpretation of 1984 and 1999/2000 aerial photographs and limited field reconnaissance. The five-value scale ranges from very low landslide potential (Category 1) to very high landslide potential (Category 5). Three geomorphologically unique areas (the mutual drainage area of Centennial and Big Mountains, the coastline, and much of the southeast quarter of the Tombs Creek 7.5' Quadrangle) were mapped and classified separately. Similarly, two areas of the Coastal Terrane were subdivided and treated individually.

The method and criteria described above for the designation of areas into relative landslide potential categories are applied to all Relative Landslide Potential Maps generated by NCWAP and THPEWRP to ensure statewide consistency.

LIMITATIONS

The categories of relative landslide potential represent a composite of the data considered. The incorporated data were remotely sensed from aerial photos taken in 1984 and 1999/2000. As such, this map is suitable for regional interpretation and is not a substitute for site level investigations. The map can be used as a screening tool during project planning to estimate the potential of landsliding but does not define risk. No interpretations were made regarding the potential consequences of landsliding. This map is based on mapping of landslides and related geomorphic features and so captures the consequences of past triggering events such as earthquakes and major storms. These events have occurred historically and caused landslides in the Gualala River watershed and are expected to occur in the future.

All mapped landslides were incorporated into the analysis. The data did not differentiate between landslides with or without a relationship to land use or land management. Therefore, the significance of anthropogenic versus natural instability cannot be interpreted based solely on the relative landslide potential map. Calibrated with other data, this map can be used in the preparation of a sediment budget. However, information regarding sediment production, landslide movement rates, erosion rates, soil erosion hazard ratings, soil depth, and bank erosion is not incorporated into this map. Consequently this map alone cannot be used to estimate surface erosion.

The map is based on observations of conditions visible in aerial photos taken during 1984 and 1999/2000. The effects of subsequent natural disturbance or land-use may cause the map to become outdated.

Studies of the stability of specific sites commonly require development of quantitative data through laboratory testing of field samples. This level of testing was not performed for this regional evaluation.

IMPORTANT NOTES

Modifications to the landscape by human activities could alter the relative stability of slopes and the relative landslide potential of those areas could change as a result.

The scale of this map limits the delineation and resolution of landslide potential areas.

The information on this map is not sufficient to serve as a substitute for geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

Digital data shown on this map as well as additional landslide and fluvial geomorphology data are available from the following sources: on the CGS website at www.conservation.ca.gov/cgs, on compact disc from CGS (CD-ROM 2002-08), or on the North Coast Watershed Assessment Program website at www.ncwatershed.ca.gov.

EXPLANATION

Surficial Deposits (Holocene-Pleistocene)

- Qbs — **Beach sand**- marine-laid deposits of fine- to coarse-grained sand and gravel; may migrate seasonally.
- Qf — **Alluvial fan**- characteristic fan-cone shapes at the mouths of eroding stream canyons; includes debris fans.
- Qmt — **Marine terrace deposits**
- Qscu — **Undifferentiated stream channel deposits**- unconsolidated sediments in active channels and flood plains.
- Qsc1 — **Stream channel deposits**- stage/return period 5 years or less
- Qrt — **River terrace deposits**
- Qoal — **Older alluvium**

Overlap (Quaternary-Tertiary)

- QTors — **Ohlson Ranch Formation**- siltstone.
- QTorc — **Ohlson Ranch Formation**- conglomerate.
- QTor — **Ohlson Ranch Formation**- undifferentiated Marine sandstone and conglomerate.

Gualala Block (Tertiary-Cretaceous)

- TKu — **Undifferentiated strata of German Rancho, Anchor Bay and Stewarts Point**- sandstone, siltstone, claystone and conglomerate.
- Tg — **German Rancho Formation**- marine sandstone and mudstone.
- Tsm — **Monterey Group**- marine sandstone and shale.
- Ka — **Gualala Formation, Anchor Bay Member**- sandstone, mudstone and conglomerate.
- Ks — **Gualala Formation, Stewarts Point Member**- sandstone, conglomerate and mudstone.
- Ksb — **Black Point Spilite**

Undifferentiated Franciscan Complex (Cretaceous)

- Kfgs — **Greenstone**
- Kfss — **Sandstone**
- sp — **Serpentinite**
- m — **Metamorphic**

Coastal Belt Franciscan, includes Coastal Terrane (Eocene-Early Cretaceous)

- TKfss — **Coastal Belt Franciscan**- marine sandstone.
- TKfs — **Coastal Belt Franciscan**- marine siltstone.

Central Belt Franciscan, includes Central Terrane (Cretaceous)

- KJfs — **Undifferentiated Central Belt Franciscan**- siltstone.

Eastern Belt Franciscan, includes Yolla Bolly and Pickett Peak Terranes (Early Cretaceous-Late Jurassic)

- Jfmg — **Melange**
- KJfm — **Central Belt Franciscan**- melange: includes chert- ch, greenstone- gs, greywacke- gwy and sandstone- ss.

Great Valley Complex (Cretaceous)

- KJgvs — **Sandstone and claystone**

ROCK SLIDE: Slope movement with bedrock as its primary source material. This class of failure includes rotational and translational landslides; relatively cohesive slide masses with failure planes that are deep-seated in comparison to those debris slides of similar areal extent. The slide plane is curved in a rotational slide. Movement along a planar joint or bedding surface may be referred to as translational. Complex versions with combinations of rotational heads and translational movement or earthflows downslope are common. indicates a scarp; arrows show direction of movement; queried where the presence of the slide is uncertain; boundary is solid where historically active, dashed where dormant, queried where uncertain.

EARTHFLOW: Slow to rapid movement of mostly fine-grained soil with some rocky debris in a semi-viscous, highly plastic state. After initial failure, the mass may flow or creep seasonally in response to changes in groundwater level. These types of slope failures often include complexes of nested rotational slides and deeply incised gullies; boundaries are usually indistinct. indicates a scarp; arrow indicates direction of movement; queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.

DEBRIS SLIDE: Mass of unconsolidated rock, colluvium, and coarse-grained soil that has moved slowly to rapidly downslope along a relatively steep, shallow, translational failure plane. Debris slides form steep, unvegetated scars in the head region and possibly irregular, hummocky deposits in the toe region. Scars commonly ravel and remain unvegetated for several seasons depending on slope aspect. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, queried where uncertain.

DEBRIS FLOW / TORRENT TRACK: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reworked and incorporated into subsequent events; lack of vegetation indicates recent activity. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.

SMALL LANDSLIDE: Landslide too small to delineate at 1:24,000 scale (typically less than 1/5 acre in area or less than 150 feet in length).

DISRUPTED GROUND: Irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at 1:24,000 scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion. Boundaries are usually indistinct.

DEBRIS SLIDE SLOPE / SOURCE AREA: A geomorphic feature characterized by steep, usually well vegetated slopes that appear to have been sculpted by numerous debris slides and debris flows. Upper reaches (source areas) of these slopes are often tightly concave and very steep. Soil and colluvium atop bedrock may be disrupted by active debris slides and debris flows. Slopes near the angle of repose may be relatively stable except where weak bedding planes, bedrock joints and fractures parallel the slope.

INNER GORGE: A geomorphic feature consisting of steep slopes adjacent to channels. The gorge typically is created by accelerated downcutting in response to regional uplift. It is defined as an area of streambank between the channel and the first break in slope. Line is queried where uncertain, or broken into segments to represent a stretch of discontinuous inner gorge too small to accurately represent at 1:24,000 scale. One-sided hachures indicate inner gorge on one side of channel only; hachures point downslope.

GULLY: Distinct, narrow channels formed by erosion of soil or soft rock material by running water. Channels are larger and deeper than rills and usually carry water only during and immediately after heavy rain or following the melting of ice or snow. Arrows point downhill; line is queried where uncertain.

Lithologic Contact: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Fault: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Lineament: Linear feature of unknown origin noted on aerial photographs.

- Watershed Boundary
- Subbasin Boundary
- County Boundary
- Public Land Survey System
- Stream
- Primary Highway
- Secondary Highway
- Road, Street or Trail
- City or Town
- Spring

CONTOUR INTERVAL 40 FEET

North American Datum of 1983 (NAD83)
Projection: Universal Transverse Mercator, Zone 10

DATA SOURCES

Watershed Boundaries	1:24,000 California Watershed Map (CALWATER v.2.2a)
Hydrography	1:24,000 USGS DLG and USFS CFF
Transportation	1:24,000 USGS DLG and USFS CFF
Hypsography	1:24,000 USGS DLG
Public Land Survey System	1:100,000 USGS DLG
County Boundaries	1:100,000 USGS DLG

RELATIVE LANDSLIDE POTENTIAL WITH GEOLOGIC AND GEOMORPHIC FEATURES GUALALA RIVER WATERSHED, SONOMA AND MENDOCINO COUNTIES, CALIFORNIA PLATE 2, SHEET 1 OF 3 (NORTHERN PORTION)

by Michael S. Fuller, CEG, Wayne D. Haydon, CEG, Michael G. Purcell, RG and Kit Custis, CEG, CHG

Digital Representation by Sandra M. Summers and Peter D. Roffers

2002

www.conservation.ca.gov/cgs

The California Department of Conservation makes no warranties as to the suitability of this product for any particular purpose.

Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.